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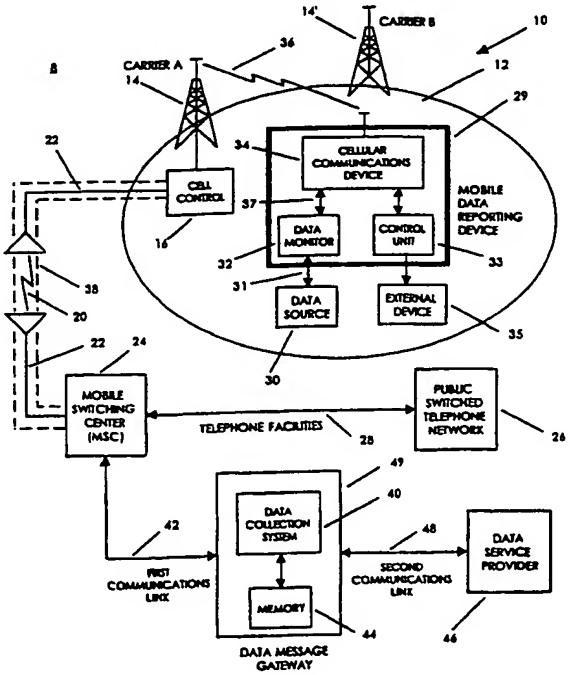
(54) Title: METHOD AND APPARATUS FOR REGISTERING THE ELECTRONIC LOCATION OF A MOBILE CELLULAR COMMUNICATIONS DEVICE



(57) Abstract: Identifying and registering the electronic location of a mobile data reporting device (MDRD) operating within the paging areas of a cellular mobile radiotelephone (CMR) system. The MDRD travels freely between CMR systems and is operative to communicate selected data collected from data sources to a data service provider via control channels of the CMR system. The location registration system enables the data collection system to transmit a data message to the mobile data reporting device via the control channels of the particular CMR system within the paging areas of which the MDRD resides. Each MDRD contains a list of System Identification Numbers that identify CMR systems that support data message communications. The SID list can be periodically updated through a series of update control messages transmitted to the MDRD. The MDRD can also identify supportive CMR systems by monitoring the data traffic on the control channels of the CMR system. Once the MDRD has determined that a particular CMR system supports data message communications, the MDRD can generate a maintenance message that apprises the data service provider as to the electronic location of the MDRD. Once the data service provider has been apprised of the electronic location of the MDRD, the service provider can transmit control messages to the MDRD via the paging area corresponding to the electronic location identified. The identification of the electronic location of the MDRD eliminates the necessity of flood paging all paging areas in which the MDRD might be located.

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METHOD AND APPARATUS FOR REGISTERING THE ELECTRONIC LOCATION OF A MOBILE CELLULAR COMMUNICATIONS DEVICE

RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/125,635, filed March 22, 1999 and is a continuation-in-part of a co-pending application Serial No. 09/083,079 filed May 21, 1998. These co-pending applications are related to yet another co-pending application Serial No. 08/622,438, filed March 25, 1996 and are related to application Serial No. 08/212,039, filed March 11, 1994, which issued as U.S. Patent No. 5,546,444.

TECHNICAL FIELD

The present invention relates generally to communicating data via a cellular network control channel of a cellular mobile radiotelephone system and more particularly relates to a method and apparatus for triggering the registration of the location of a mobile cellular communications device.

BACKGROUND OF THE INVENTION

The communications industry has developed and manufactured a number of communications devices and methods aimed at satisfying a large and ever-growing demand for communicating data. For industrial applications, for example, there may be a need to maintain a central data collection site for acquiring information from a variety of remotely located monitoring devices that collect data about the operation or performance of industrial equipment. Operators of such a central data collection site also may have a need to cause a remotely located device to perform some operation. Communications systems and methods for transmitting information and/or control signals are collectively referred to as telemetry.

Generally, telemetry is the technology of automatic data measurement and transmission, as by wire or radio, from remote devices, to a central station for recording and analysis. Telemetry can also involve communications in the opposite direction, i.e., from the central station to the remote devices. For the purposes of this discussion, data communication from

the central station to the remote device is termed "forward communication"; data communication from the remote device to the central station is termed "reverse communication". Data communication in both directions may be utilized to provide a closed loop control system. For example, the operator of an oil pipeline may control flow within the pipeline by controlling the opening of a valve in the pipeline. In the oil pipeline example, a reverse communication could provide to the operator data on the flow of oil through the pipeline. A forward communication could transmit a signal from the operator to a valve to reduce the flow of oil, thereby completing the closed loop control system.

Wireless communications have been extensively used to support telemetry systems. A common form of wireless communication for both voice and data transmissions is the cellular mobile radiotelephone (CMR) system, which is connected to the extensive public switched telephone network (PSTN) and permits communications between a mobile radiotelephone user and anyone with a conventional telephone (or another radiotelephone). Typical CMR systems are characterized by dividing a radio paging area into smaller paging areas or "cells" using low power transmitters and coverage-restricted receivers. CMR systems typically include control channels for transmitting data for establishing communication between the CMR system and a radiotelephone and voice channels for providing real-time communications between a radiotelephone and the telephone or radiotelephone of another party. As shown in U.S. Patent Nos. 3,906,166 and 4,268,722, the limited paging area enables the radio channels used in one cell to be reused in another cell. As a cellular mobile radiotelephone within one cell moves across the boundary of the cell and into an adjacent cell, control circuitry associated with the cells detects that the signal strength of the radiotelephone in the just-entered cell is stronger, and communications with the radiotelephone are "handed-off" to the just-entered cell. Thus, a CMR system can supply two-way communications for an array of cells, thereby supplying communications for a much wider area than conventional two-way wireless communication systems.

Many of the telemetry systems that have been made available by the communications industry utilize existing CMR systems. The benefit of these telemetry systems is that they are operable within the architecture of the existing CMR systems and, therefore, are readily and inexpensively implemented. Unfortunately, many such telemetry systems utilize the voice channels of the radiotelephone system to transmit data-only communications by real-time communication over the voice channels. As discussed above, conventional CMR systems generally provide both voice channels and control channels and radiotelephone service is generally supplied at a cost that is commensurate with

the combined voice and data services. That is, a radiotelephone user must pay for the use of both the voice channel and the control channel of the CMR system. This combination of both voice channel and control channel communications may exceed a user's requirements for communicating only data, because a real-time communication channel may not be needed and the control channel may be adequate for such data-only usage. Real-time voice or data communications is not always desirable to a user who wishes only to receive a message without having a current activity disturbed. As with any wireless communication system, the frequency spectrum for the CMR system radio channels, particularly voice channels, is a limited resource and must be conserved to operate a CMR system efficiently.

U.S. Patent No. 5,546,444, describes a system for obtaining data and communicating data (rather than voices) over the control channels of a CMR system. Utilizing the control channels to communicate data helps to conserve the valuable frequency spectrum allocated for the voice channels that support normal telephonic conversations on the CMR system. Additionally, the user can usually can avoid the added expense of voice channel usage by utilizing only a control channel. Because the system can be implemented within the confines of the conventional CMR system, no significant modification is required to accommodate the ability to communicate data over the control channels.

An illustration of the use of a control channel to communicate data is provided by the oil pipeline example discussed above. By connecting a modified radiotelephone transceiver to a flow meter, data generated by the flow meter can be collected by a monitoring device and communicated by the transceiver, via the control channel, to a central data collection system. An interface between the monitor and the transceiver can convert the data to a format that is communicable by the transceiver. This combination of a transceiver, monitor, and interface operates as a data reporting device. The central data collection system can transmit a message (*i.e.*, control message) via a forward control channel (FOCC), to the data reporting device in order to trigger a communication of the collected data. The data reporting device can respond by transmitting a message via a reverse control channel (RECC), to the central data collection system. Instead of sending the information normally used for registering the device's identity or originating a call request, however, the data reporting device can replace such information with the collected data for transmission via the control channel. Without establishing a voice channel connection, the collected data is, nonetheless, communicated to the central data collection system.

Reverse communications (via the RECC) of selected data, by a data reporting device, are referred to as data messages. Forward communications (via the FOCC) are referred to as control messages. Control messages contain a mobile identification number (MIN) which identifies the cellular device (e.g., a radiotelephone transceiver) to which the control message is directed. Typically, only cellular devices with a matching MIN stored in memory will respond to the control message. The most common type of control message is the page message, which notifies the cellular device of an incoming call. Other control messages instruct the cellular device to perform other communication functions, such as to display a message waiting indicator or to generate an autonomous registration.

A data reporting device can be programmed to respond to a control message, received from the data collection system, by performing operations other than simply sending a data message to the data collection system. By equipping the data reporting device with a control unit, rather than (or in addition to) a monitor, the data reporting device can be utilized to provide a means of remote control. Returning to the oil pipeline example, the data collection system may transmit a control message to the data reporting device to close the oil pipeline valve. In this simple case, the data reporting device is programmed to trigger the valve closing when the device receives the control message from the data collection system. A second data reporting device could be used to open the valve when the second data reporting device receives a control message. Thus, by "calling" the first data reporting device, the data collection system closes the valve and, by "calling" the second data reporting device, the data collection system opens the valve.

Mobile data reporting devices can be used to monitor and/or control the activity of mobile data sources such as a long-haul truck. Long-haul trucking companies have a desire to monitor various aspects of trucks that are in transit and are scattered all over the country. By placing a mobile data reporting device on the truck, trailer, or container, this data can be collected and communicated back to a central data collection system. For example, a truck may be equipped with a Global Positioning System sensor that generates the coordinates of the truck's location. By sending that data back to the data collection system, the long-haul trucking company could keep track of the truck's movements at all times. Similarly, the data could include the current temperature of a refrigerated compartment, the number of containers aboard the truck, or the speed of travel. However, unlike the data reporting device in the oil pipeline example, the mobile data reporting device may travel between CMR system cells and between CMR systems. Thus, the data collection system will need to be told in which CMR

system the long-haul truck resides, so that the data collection system can communicate with the mobile data reporting device in the forward direction, via the FOCC.

This mobile data reporting device can communicate with the data collection system in the reverse direction, as can any radiotelephone in a "foreign" CMR system, via the RECC. The data collection system described in U.S. Patent No. 5,546,444 does not readily accommodate mobile data reporting devices, in that it does not inform the data collection system as to the location of a mobile data reporting device that has left a particular CMR system. In order for the data collection system to communicate in the forward direction to a mobile data reporting device in a foreign CMR system, it would have to send out a page in multiple CMR systems. This is an expensive and ineffectual means of establishing forward communications, because it would result in an overuse of the forward direction control channels of the CMR systems' cells.

Typically, CMR systems require a radiotelephone to transmit an "autonomous registration signal" when the radiotelephone enters one CMR system (e.g., a "foreign" system) from another CMR system (e.g., a "home" system). A radiotelephone typically determines whether it has entered the paging area of a foreign CMR system by comparing a SID assigned to the radiotelephone's home CMR system to the SID most recently received. Conventional CMR systems transmit a control message containing a SID over the FOCC. If the assigned SID is different from the SID most recently received, then the radiotelephone determines that it has moved into a foreign CMR system. However, some CMR systems do not transmit a SID different than that generated by adjacent CMR systems. In such cases, the radiotelephone cannot determine that it needs to transmit the autonomous registration signal and roaming is not enabled. A radiotelephone that is within the paging area of such a CMR system is "lost" to the radiotelephone's home CMR system and cannot receive incoming calls without flooding the FOCCs of multiple CMR systems with a page to initiate contact with the radiotelephone.

For the stationary data reporting device, such as the oil pipeline monitoring example, this does not present a problem, because the monitor never changes location, and the "home" CMR system knows where the remote data reporting device can be located, should communication in the forward direction be required. However, many applications of such data collection systems require the ability to communicate in the forward direction (i.e., from the data collection system to the data reporting device). To do so, the central data collection entity must know in which CMR system the data reporting device resides. Without this information, the central data collection entity would have

to request a page in all CMR systems in order to locate the data collection device, which would result in an overuse of the forward direction control channels of the CMR systems.

There is another problem with collecting data from mobile data reporting devices that the data collection system described in U.S. Patent No. 5,546,444 does not accommodate. The problem occurs because not every CMR system is equipped to support a data collection system. Where a data collection system incorporates a mobile data reporting device, the mobile data reporting device may, on occasion, roam into a CMR system's paging area where the CMR system is not equipped to cooperate with the data collection system. Until the mobile data reporting device roams into a CMR system that is so equipped, it will be lost to the home CMR system and data communication will be impossible.

This problem is addressed by the invention if the co-pending application Serial No. 09/083,079 by enabling the mobile data reporting units to generate a registration signal in response to a determination that the mobile data reporting unit had traveled into the paging area of a new CMR system. The registration signal is used to inform the mobile data reporting unit's "home" CMR system of the identity of the "foreign" CMR system into which the mobile data reporting unit had entered. Once the registration signal is received by the "home" CMR system, it is able to transmit control messages to the mobile data reporting unit over the FOCC. A beacon page communicated by each CMR system provides one means for triggering the mobile data reporting unit to generate the registration signal. However, some CMR systems are not equipped to efficiently communicate beacon pages on an on-going basis. Thus, a mobile unit that is configured to generate a registration signal may not do so and the mobile data reporting unit will be "lost" to the "home" CMR system.

Accordingly, there is a need to overcome the limitations of the prior art by adapting an existing communications network to more efficiently communicate data between a central location and numerous mobile data reporting devices in both forward and reverse directions. There is a need to configure the mobile data reporting devices such that they are capable of communicating data to the central data collection system despite being within the paging area of a CMR system that is not equipped to accommodate data communication. There is also a need for triggering a mobile data reporting unit to generate a registration signal despite the lack of a beacon page. This new use of an existing communications system should have a minimum impact upon present communications carried by the CMR system. The present invention adapts the existing architecture of a CMR system in an efficient and cost-

effective manner to support data communications via the CMR system, including the collection and reporting of data recorded by mobile data reporting devices that travel between CMR systems.

SUMMARY OF THE INVENTION

The present invention solves the problems of the prior art by providing a data message system for communicating data collected from data sources. The data message system includes a set of mobile data reporting devices (MDRDs), at least one mobile switching center (MSC) of a cellular mobile radiotelephone system (CMR) system, and a data message gateway connected to the MSC. Each MDRD monitors the operation of one or more data sources to obtain selected data. The MDRD can transmit a data message containing the selected data to the MSC via a cellular network control channel of the CMR system. The MSC receives data messages from MDRDs operating within paging areas of the CMR system. The MSC can send the data messages to a data message gateway via a first communications link for processing of the information contained in the data messages. The data message gateway can, in turn, transmit the selected data to a data service provider via a second communications link.

By operating within the environment of a CMR system, which is well adapted for mobile cellular communications, the present invention takes advantage of an existing wide area communications network and avoids the expense of communicating with each remote data source via a dedicated conventional telephone facility or via conventional two-way radios. The data message system adapts the existing environment of a CMR system to communicate data from one or more MDRDs to a central location (the data message gateway). However, to conserve the use of voice channels of the CMR system for conventional telephone conversations (or other applications requiring real-time communications), the data message system uses the cellular network control channels of the CMR system for data communications.

While the MDRDs can be used to collect data, they are also responsive to control messages received from the MSC. A control message directed to a MDRD may cause the MDRD to generate a data message containing selected data or it may cause the MDRD to perform some other operation. In any case, the data service provider by which the control message is initiated must know the electronic location of the MDRD. The electronic location of an MDRD comprises the identity of the CMR system and MSC with which the radiotelephone unit is communicating. Specifically, the typical CMR system has a System Identification Number (SID) and the MSC has a switch

number. The ability of the MDRD and the data service provider to communicate data and control messages depends on the ability of a particular CMR system to support data message communications. Therefore, it is important that the MDRD determine its electronic location and whether the CMR system serving the paging area corresponding to the MDRD's electronic location supports data message communications.

In one aspect of the present invention, the electronic location of an MDRD can be determined by means of a maintenance message. When the MDRD recognizes the occurrence of a triggering event, the MDRD will generate a maintenance message which is received by the MSC and conveyed ultimately to the data service provider. The maintenance message informs the data service provider of the MDRD's electronic location. After the data service provider has been apprised of the MDRD's electronic location, the data service provider can transmit control messages to the MDRD by paging only the paging area identified in the maintenance message. This maintenance message function minimizes the occurrences wherein the MDRD is lost to the data service provider. A maintenance message can be triggered by various events, including a change in a received SID as compared with a previously received SID.

In another aspect of the present invention, the MDRD is provided with a SID list, permitting the MDRD to determine whether a particular CMR system supports data message communication. As with a typical cellular radiotelephone, the MDRD monitors the control channels of a CMR system and receives a SID identifying the CMR system to the MDRD. By comparing a received SID to the SIDs contained in the MDRD's SID list, the MDRD can make a determination as to whether the CMR system is a known supporter of data message communications. If the CMR system is a known supporter of data message communications, then the MDRD will generate a maintenance message to inform the data service provider of the MDRD's electronic location.

In another aspect of the invention, the SID list can be updated by accessing a Master SID list that is maintained by the data message gateway or some other central site. As CMR systems are added or deleted from the list of CMR systems supporting data message communication, the Master SID List can be updated to reflect those additions and/or deletions. By transmitting update control messages to the MDRDs, the data message gateway can keep the MDRDs' SID lists current. Moreover, when an MDRD discovers a CMR system that supports data message communications, but is not listed on the SID list, the MDRD can transmit a message to the data message gateway to add the CMR system's SID to the Master SID List.

In yet another aspect of the invention, the MDRD can monitor the cellular communications traffic in a particular paging area to determine whether the corresponding CMR system is supportive of data message communications. Typically, the data transmissions traveling over the control channels of the CMR system during data message communications are identifiable by some unique characteristic. The MDRD's can be configured to monitor the communication traffic on the control channels of the CMR system to look for some predetermined characteristic of data message communications. When the MDRD detects the predetermined characteristic, the MDRD will generate a maintenance message to apprise the data service provider of the MDRD's electronic location.

In still another aspect of the present inventions, the MDRD can maintain a record of the trigger event that corresponds to each CMR system on the SID list. This is accomplished by maintaining a trigger flag in the SID list for each SID. When the MDRD detects that it is in a CMR system listed in the SID list, then the MDRD will generate a maintenance message in response to whatever trigger event is identified by the trigger flag.

These and other objects, features, and advantages of the present invention may be more clearly understood and appreciated from a review of the following detailed description and by reference to the appended drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an exemplary embodiment of a data message system in the operating environment of a CMR system.

FIG. 2 is a block diagram of an exemplary embodiment of a data message system in the operating environment of a plurality of CMR systems.

FIG. 3 is a block diagram that shows the System Identification Number comparison mechanism of an embodiment of the present invention.

FIGs. 4a and 4b are flow chart diagrams that show the steps for an exemplary method for registering the electronic location of a mobile data reporting device.

FIGs. 5a and 5b are flow chart diagrams that show the steps for an exemplary method for registering the electronic location of a mobile data reporting device.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The present invention provides a data message system for communicating data collected from data sources. The data message system includes a set of mobile data reporting devices (MDRDs), at least one mobile switching center (MSC) of a cellular mobile radiotelephone system (CMR) system, and a data message gateway connected to the MSC. Each MDRD monitors the operation of one or more data sources to obtain selected data. The MDRD can transmit a data message containing the selected data to the MSC via a cellular network control channel of the CMR system. The MSC receives data messages from MDRDs operating within paging areas of the CMR system. The MSC can send the data messages to a data message gateway via a first communications link for processing of the information contained in the data messages. The data message gateway can, in turn, transmit the selected data to a data service provider via a second communications link.

By operating within the environment of a CMR system, which is well adapted for mobile cellular communications, the present invention takes advantage of an existing wide area communications network and avoids the expense of communicating with each remote data source via a dedicated conventional telephone facility or via conventional two-way radios. The data message system adapts the existing environment of a CMR system to communicate data from one or more MDRDs to a central location (the data message gateway). However, to conserve the use of voice channels of the CMR system for conventional telephone conversations (or other applications requiring real-time communications), the data message system uses the cellular network control channels of the CMR system for data communications.

While the MDRDs can be used to collect data, they are also responsive to control messages received from the MSC. A control message directed to a MDRD may cause the MDRD to generate a data message containing selected data or it may cause the MDRD to perform some other operation. In any case, the data service provider by which the control message is initiated must know the electronic location of the MDRD. The electronic location of an MDRD comprises the identity of the CMR system and MSC with which the radiotelephone unit is communicating. Specifically, the typical CMR system has a System Identification Number (SID) and the MSC has a switch number. The ability of the MDRD and the data service provider to communicate data and control messages depends on the ability of a particular CMR system to support data message communications. Therefore, it is important that the MDRD determine its electronic location and whether the CMR system serving

the paging area corresponding to the MDRD's electronic location supports data message communications.

The electronic location of an MDRD can be determined by means of a maintenance message. When the MDRD recognizes the occurrence of a triggering event, the MDRD will generate a maintenance message which is received by the MSC and conveyed ultimately to the data service provider. The maintenance message informs the data service provider of the MDRD's electronic location. After the data service provider has been apprised of the MDRD's electronic location, the data service provider can transmit control messages to the MDRD by paging only the paging area identified in the maintenance message. This maintenance message function minimizes the occurrences wherein the MDRD is lost to the data service provider. A maintenance message can be triggered by various events, including a change in a received SID as compared with a previously received SID.

The MDRD is provided with a SID list, permitting the MDRD to determine whether a particular CMR system supports data message communication. As with a typical cellular radiotelephone, the MDRD monitors the control channels of a CMR system and receives a SID identifying the CMR system to the MDRD. By comparing a received SID to the SIDs contained in the MDRD's SID list, the MDRD can make a determination as to whether the CMR system is a known supporter of data message communications. If the CMR system is a known supporter of data message communications, then the MDRD will generate a maintenance message to inform the data service provider of the MDRD's electronic location.

The SID list can be updated by accessing a Master SID list that is maintained by the data message gateway or some other central site. As CMR systems are added or deleted from the list of CMR systems supporting data message communication, the Master SID List can be updated to reflect those additions and/or deletions. By transmitting update control messages to the MDRDs, the data message gateway can keep the MDRDs' SID lists current. Moreover, when an MDRD discovers a CMR system that supports data message communications, but is not listed on the SID list, the MDRD can transmit a message to the data message gateway to add the CMR system's SID to the Master SID List.

The MDRD can monitor the cellular communications traffic in a particular paging area to determine whether the corresponding CMR system is supportive of data message communications. Typically, the data transmissions traveling over the control channels of the CMR system during data message communications are identifiable by some unique characteristic. The MDRD's

can be configured to monitor the communication traffic on the control channels of the CMR system to look for some predetermined characteristic of data message communications. When the MDRD detects the predetermined characteristic, the MDRD will generate a maintenance message to apprise the data service provider of the MDRD's electronic location.

The MDRD can maintain a record of the trigger event that corresponds to each CMR system on the SID list. This is accomplished by maintaining a trigger flag in the SID list for each SID. When the MDRD detects that it is in a CMR system listed in the SID list, then the MDRD will generate a maintenance message in response to whatever trigger event is identified by the trigger flag.

In view of the foregoing, it will be understood that the present invention adapts the existing architecture and communications protocols for a conventional CMR system to supply a novel and economical approach to the communication of data collected from numerous mobile sites. It will be further understood that the communication of data messages between an MSC and the MDRD is primarily based upon conventional techniques and known protocols for CMR system communications. Accordingly, prior to describing the embodiments of the present invention, it will be useful to first review the primary components and operation of a typical CMR system.

Cellular Mobile Radiotelephone System

A CMR system is generally characterized by dividing a radio paging area into smaller paging areas or "cells" using low power transmitters and coverage-restricted receivers. As will be known to those skilled in the art, the limited paging area allows the radio channels used in one cell to be reused in another cell. As a mobile radiotelephone within one cell moves across the boundary of the cell and into an adjacent cell, control circuitry associated with the cells detects that the signal strength of the mobile radiotelephone in the just-entered cell is stronger, and communications with the mobile radiotelephone are "handed-off" to the just-entered cell.

A CMR system typically uses a pair of radio frequencies for each radio channel and each cell. Each cell typically includes at least one signaling channel, also referred to as a cellular network control channel or an access channel, and several voice channels. The control channel is dedicated to receive requests for service from mobile radiotelephone units (or other cellular devices), to convey orders to selected mobiles or portables (e.g., notification of an incoming call "page"), and to instruct the mobiles or portables to tune to a

predetermined voice channel where a conversation (i.e., real-time communication) may take place. Accordingly, the control channel is typically responsible for receiving and transmitting data to control the communication functions of the cellular devices within the paging areas of the CMR system. Cellular devices typically continually monitor the control channels of the CMR system for such communication information.

The control channel normally comprises a Forward Control Channel (FOCC) for communications from the MSC to a radiotelephone unit and a Reverse Control Channel (RECC) for communications from a radiotelephone unit to the MSC. The FOCC supplies a multiplexed data stream of control messages and busy idle bits. The busy idle bits are useful for supplying an indication to radiotelephones monitoring the FOCC about the current status of the RECC. In particular, the busy idle bit supplies an instantaneous view of the signaling activity on the control channel, and a conventional radiotelephone is responsive to this instant snapshot of control channel activity.

The data message and radio channel specifications for U.S. cellular radiotelephone systems are set forth in Electronic Industries Association/Telecommunications Industry Association (EIA/TIA) Standard 553, implemented in accordance with 47 C.F.R. § 22, in the Report and Orders pertaining to Federal Communications Commission (FCC) Docket No. 79-318. Copies of the EIA/TIA-553 may be obtained from the Engineering Department of the Electronic Industries Association at 2001 Pennsylvania Avenue, N.W., Washington, D.C., USA 20006. A more comprehensive discussion of the operation of control channels is provided by the co-pending application Serial No. 09/083,079 filed May 21, 1998 which is hereby incorporated by reference.

It is known that when a cellular mobile radiotelephone originates a call, it transmits at least one data message to the serving cell of the CMR system. This request for a cellular voice channel, commonly referred to as a call origination function, is defined by EIA/TIA-553 and can be implemented as a message or signal having certain defined fields. For example, this call origination message can contain data fields for the low order seven digits of the unit's Mobile Identification Number (MIN), the unit's Station Class Mark (SCM), which identifies functional characteristics of the unit, and the Called Address, or dialed telephone number. Cellular system operators typically also require additional data words to be transmitted within a call origination message, including the MIN2, which is the high order three digits or NPA of the cellular device's Mobile Identification Number (typically referred to as the "area code"), and the Electronic Serial Number (ESN).

The MIN is assigned to a particular radiotelephone unit by the cellular service provider selected by the subscriber. The MIN typically contains information unique to a particular CMR system operator, for example, the three digits of the MIN2 ("XXX") typically correspond to an area code, the first three digits of the MIN ("XXX") typically correspond to a geographic location within the area code; and the final four digits of the MIN ("XXXX") identify a particular piece of equipment. The inventors contemplate the use of MINs and MIN2s that have no correlation with the physical location of the particular radiotelephone. Thus, the MIN/MIN2 is simply an identifying code or characteristic of the particular radiotelephone. Similarly, the ESN is unique to each mobile cellular radiotelephone unit, and comprises a format that allows differentiation as to manufacturer and, in some cases, the model number, date of manufacture, and the like. As long as no radiotelephone or cellular device within a CMR system is assigned the same MIN/MIN2 as another device, then the cellular device can be contacted individually. Conversely, if more than one cellular device is assigned the same MIN/MIN2, then the devices can be contacted as a group.

The call origination message is provided first to the serving cell of the CMR system, and then through a data link to a mobile switching center (MSC). The MSC, also known as a "switch," makes voice connections between mobile radiotelephones and other telecommunications networks. At the MSC, a determination is typically made whether the "calling" radiotelephone identified by the message is an authorized user or subscriber by looking up the unit's MIN, serial number (ESN), and other information supplied by the message to see if there is an entry in the MSC's database corresponding to that particular telephone. If the MIN is valid and the radiotelephone is identified as a subscriber within the given cellular system, i.e., a "home" unit, the MSC compares the received ESN to a database entry to detect fraud. If these checks succeed, the cellular call is then allowed to proceed with establishing communications over the CMR system.

It is also well known that when a mobile radiotelephone first powers up or first enters a CMR system when already powered, the unit can identify itself as actively present within the system. The radiotelephone identifies itself or "registers" through a process known as autonomous registration by supplying a data packet of information similar to that of a call origination message. The autonomous registration signal, typically comprises data fields for at least a MIN, and an ESN. Unlike the autonomous registration signal, the call origination signal can include a data field containing the digits of the telephone number to be called, and a flag within a data field to distinguish

this message from an autonomous registration signal. The flag may also be used as a means for conveying information to the MSC and/or CMR system.

The original design objective of the autonomous registration signal was to improve the efficiency of potential future call deliveries by keeping the MSC informed of the approximate location of each individual radiotelephone unit, and to reduce paging channel load by lessening the need to page all cells to find a particular cellular device. When the MSC is thus informed, it can later page the cellular device only in the cell or area in which the cellular device was last known to be in. Additional cells would be paged only if the initial page did not locate the particular radiotelephone. Thus, the autonomous registration function is typically implemented as messages periodically and autonomously sent from the mobile radiotelephone to the serving cell at an interval specified in data parameters previously received from the cell by the cellular device.

A subscriber using or attempting to use his or her mobile radiotelephone in a service area outside the home service area is said to be "roaming," and the subscriber (and the associated cellular device) is commonly referred to as a "roamer." For example, if a subscriber enters the service area of another CMR system data service provider and powers on the radiotelephone, the radiotelephone will monitor the FOCC of the CMR system. Eventually, the radiotelephone will receive a control message via the FOCC of the particular cell in which the telephone then resides. The control message, also known as a System Parameter Overhead Message (SPOM) identifies the CMR system in which the radiotelephone is residing by including a system identification number (SID) that is assigned to the CMR system. The radiotelephone will respond to the receipt of a "foreign" SID (i.e., an SID different from the radiotelephone's home CMR system's SID) by registering for operation in the foreign CMR system. In response, both the Mobile Identification Number (MIN) and the electronic serial number (ESN) for the radiotelephone unit are transmitted as identifying information back to the cell site. The cell forwards this information to an MSC, which quickly ascertains whether the radiotelephone unit is a customer of the local cellular service provider or the customer of another cellular system.

Other control messages may be equipped with other data that can be used, like a SID, as an identifying characteristic of the CMR system. For example, a typical CMR system has a clock-like signal, referred to as a REGID. The REGID is an integer value that is constantly being incremented by the CMR system. A typical CMR system will also generate a REGINCR value, which is constant, but represents a threshold increment for comparison of REGID values. Cellular devices within the paging area of the CMR system, monitor the control

messages transmitted by the CMR system and receive the REGID and REGINCR values. By adding the REGINCR value to the REGID value, the radiotelephone calculates and stores a NEXTREG value. The NEXTREG value will determine when the radiotelephone will next register for operation in the CMR system. Specifically, when a REGID value received by the radiotelephone is greater than the NEXTREG value, then the radiotelephone will register with the CMR system. The radiotelephone can also be triggered to register when the REGID varies drastically from a previously received REGID. This will typically happen when the radiotelephone is moved from one CMR system to another CMR system transmitting a different REGID in a control message. Those skilled in the arts will recognize that various other means can be used to trigger a registration by the radiotelephone.

If the cellular device is a customer of another cellular service provider, the MSC will send a message packet to the home system for the particular telephone unit. This message indicates that the particular cellular device has registered in another cellular system and includes the SID and MSC number (i.e., switch number) identifying the foreign CMR system and the related MSC, respectively. This message serves as a request for information about the validity of the number and account information for the radiotelephone unit. The home system responds by transmitting a responsive packet containing the requested information. If valid, the mobile switching center at the foreign cellular system will then add the roamer to its list of registered users and the home cellular system will add the subscriber associated with the radiotelephone unit to a list of roamers that are out of the service area and registered in another area.

When this cellular device registers with yet another system, the database at the mobile switching center for the home system will observe that the unit has moved again and will update its list of where the roaming unit has most recently registered in a database system. In addition, it will send a message to the first foreign system informing it that the roaming unit has now moved on and registered in another system, and that the first foreign system should delete the particular unit from its list of registered roamers. In this manner, the databases at the various mobile switching centers are not cluttered with data identifying previously registered roamers as valid accounts to whom service should be provided, when these roamers may have long since left the area of service.

For a given geographical region, for example, the United States, a network of CMR systems is typically used to provide coverage of substantial portions of the geographical region. Each CMR system may have any number of

MSCs and paging areas. For the purposes of this discussion, the term "CMR system" is used to include both a single CMR system as well as a network of individual CMR systems.

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Data Message System

Referring now to the drawings, in which like numerals indicate like elements throughout the various figures, FIG. 1 illustrates an exemplary embodiment of a data message system 10 in an exemplary environment of a cellular mobile radiotelephone (CMR) system 8. Referring to FIG. 1, the data message system 10 supports the collection and communication of data to a central data collection site by mobile reporting systems associated with numerous data sources. A typical CMR system includes a paging area, such as indicated by the cell 12, of which a plurality of cells are typically provided in a typical CMR system. The cell 12 is served by broadcast antennas 14 and 14' to permit communications between cellular mobile radiotelephones operating within the cell 12 and a cell control 16. A mobile telephone switching office, such as the mobile switching center (MSC) 24, can communicate with the cell 12 either by dedicated telephone facilities (not shown) or, more frequently, by a cell-to-mobile switching center data link 22 between the cell control 16 and the MSC 24. At least a portion of the data link 22 is typically supported by a wireless communications link, such as the microwave link 20, located between the cell 12 and the MSC 24.

It is well known to those skilled in the art that a conventional CMR system comprises at least one mobile telephone switch coupled to an appropriate array of more or less identically equipped cell sites 12. The MSC 24 normally couples telephone conversations involving mobile radiotelephones operating in the cell 12 to the public switched telephone network (PSTN) 26 through telephone facilities 28.

The data message system 10 includes one or more mobile data reporting devices (MDRDs) 29, each comprising at least one data monitor 32 for collecting data from one or more data sources 30 and a mobile cellular communications device 34 for communicating the collected data via a control channel of the CMR system to the MSC 24. The data monitor 32, which is connected to a corresponding data source 30 via a signal path 31, obtains and records selected data directed to the operation or performance characteristics of the data source 30. In turn, the mobile cellular communications device 34, which is connected to the corresponding data monitor 32 via a signal path 37, prepares a data packet containing the selected data and transmits the packet as a data message. The selected data represents actual data acquired by the monitor 32 in response to monitoring the operation or performance of the data source 30. Alternatively, the selected data can represent predetermined data or a

preprogrammed message that is associated with the detection of a certain event by the monitor 32 for the data source 30.

The data source 30 may be either a mobile data source to which a corresponding mobile cellular communications device 34 is attached, or a stationary data source between which the mobile cellular communications device 34 travels collecting monitored data. An example of a mobile data source is that of a long-haul truck. Various aspects of a long-haul truck are monitored by the monitor 32 and transmitted to the data collection system 40 via the MDRD 29. The data source 30 might be a temperature gauge or a speedometer or any other device capable of producing data. Alternatively, the data source 30 could be stationary. For example, a cross-country train could transport a mobile cellular communications device 34 which was connected to a monitor that is capable of monitoring the inventory of various warehouses along the cross-country train's route. In either case, the data collection system 40 must be capable of communicating with the mobile cellular communications device 34.

The MDRDs 29 may also include a control unit 33 for controlling an external device 35. An operation identifier can be sent within a control message from the MSC 24 over the FOCC to the cellular communications device 34. The operation identifier can be formatted as part of the control message. Thus, all of the cellular devices in the cell, for which the MIN included in the control message provides a match, can respond to the control message. However, instead of performing operations to establish a voice channel, the MDRD 29 can forward the operation identifier contained in the control message to the control unit 33. The control unit can correlate the operation identifier to a predetermined corresponding operation, and cause the external device 35 to perform the operation. Because numerous MDRDs 29 can have the same MIN, a single control message can cause numerous external devices 35 to perform the same or different operations. Alternatively, the data reporting device 29 may be equipped to perform the operation itself, without an external device 35.

The MSC 24 can receive the data message, from the MDRD 29, via a cellular network control channel 38 formed by the combination of the data link 22 and a cellular communications link 36 between the broadcast antenna 14 and the mobile cellular communications device 34. This combination of communications links is collectively referred to as the control channel. It is well known that a cellular network control channel for a conventional CMR system comprises two radio channels that are commonly described as an FOCC and an RECC. The FOCC is used for communications initiated by the MSC to a radiotelephone unit. The RECC is used for communications from the radiotelephone to the MSC 24. The communications operations of an exemplary

embodiment also use this convention for communications between the MSC 24 and the MDRD 29. In particular, the control channel 38 comprises two separate data communications paths, an FOCC for communications initiated by the MSC 24 and an RECC for communications initiated by the MDRDs 29 (or any other cellular devices operating within the cell). Accordingly, the MDRD 29 transmits data messages via the RECC, whereas the MSC 24 transmits control messages via the FOCC. Data messages transmitted via the FOCC are referred to as forward data messages. Data messages transmitted via the RECC are referred to as reverse data messages.

In this manner, the MSC 24 can receive data messages from each of the MDRDs 29 operating within the paging areas of an array of cells for the CMR system 8. Although the data messages contain selected data rather than the parameters normally contained in an actual radiotelephone control information, the MSC 24 will operate upon the data messages as if they were transmitted by a conventional cellular radiotelephone unit operating within the paging area of the CMR system because the data messages are formatted to appear as a conventional call origination signal (or other command message) generated by a radiotelephone unit.

The MSC 24, in response to a data message, can conduct one or more of the following operations: store the data message for processing at a later date, process the selected data supplied by the data message, or forward the data message to a data message gateway 49, via a first communications link 42. The first communications link 42 is typically implemented as an IS-41/SS7 standard telecommunications signaling link, well known to those skilled in the art. The data message gateway includes a data collection system 40, a memory unit 44, a second communications link 48 and a data service provider 46. The data collection system 40, which is preferably connected to the memory storage device 44, collects the selected data by storing the received data messages within the memory storage device 44. Similar to the MSC 24, the data collection system 40 also can process the selected data to obtain further information concerning the operation or performance of the data sources 30. The data collection system 40 and the memory storage device 44 are collectively referred to as the data message gateway 49.

The data message gateway 49 can send the information of the data message to a data service provider 46 via a second communications link 48. The data service provider 46 is typically remotely located from the data collection system 40 and facilitates convenient processing of the selected data at a central site. The second communications link 48 is typically implemented by a conventional telephone facility, a dedicated data link (e.g., Internet, Intranet), or

by a wireless communications link. In the example of the long-haul truck tracking, the data service provider 46 might sell its data collection services to a trucking company that desires to maintain data on its trucks. Arrangements may be made between the trucking company and the data service provider to collect data at certain times or at certain intervals. Similarly, the trucking company may want to transmit a command message to an MDRD 29 in order to perform some remote operation.

In either case, the data service provider 46 functions as the access point at which the trucking company can gather data from and transmit commands to MDRDs 29. Similarly, the data message gateway 49 provides access to the data service provider 46. The data service provider 46 appears to the CMR system to be a foreign CMR system. Thus, when an MDRD 29 travels into a new paging area, an autonomous registration signal will be transmitted to the MSC 24 and forwarded to the data service provider 46. Once the data service provider 46 receives the autonomous registration signal, it can transmit control messages to the MDRD 29 in the paging area (electronic location) identified by the

The inventors foresee numerous communications applications for the data collection system 10, including communicating data collected from a wide variety of data sources, such as long-haul truck tracking, oil field pipeline control systems, asset tracking, and mobile alarms or distress signaling.

The general details of the data message format are disclosed in U.S. Patent No. 5,546,444 issued to Peter O. Roach, Jr., Edward I. Comer, Charles M. Link, II, and Maurice Laster and assigned to BellSouth Corporation. A further discussion of the data message format in which the call origination format is utilized is disclosed in a co-pending U.S. patent application of Edward I. Comer and Peter Roach, Jr., Serial No. 08/622,438, filed March 26, 1996, and assigned to BellSouth Corporation. Both are incorporated herein by reference.

Generally, data messages are packets of data that are transmitted via the RECC from the MDRD 29 to the MSC 24 and on to the data message gateway 49. The data messages contain selected data rather than the data necessary to establish a voice channel connection between a cellular device and another telephone. For example, the MIN, MIN2, and ESN portions of the data message can be used to transmit the selected data. As stated above, in an exemplary embodiment of the present invention, the data message can be formatted as a call origination signal or as an autonomous registration signal. Of course, any data packet that can be conveyed by the RECC to the data message gateway may provide a suitable format for the transmission of selected data.

A more detailed description of embodiments of the MDRDs 29 and the communication between an MDRD and the data message gateway 49 is provided in the co-pending parent application Serial No. 09/083,079 filed May 21, 1998. For the purposes of understanding the invention of the present invention, it is sufficient to state that the data collection system 10 provides for two-way data communications between the data message gateway 49 and each MDRD 29 within the paging areas of one or more CMR systems. Selected data is communicated via a data message over the RECC and control messages are sent to the MDRDs 29 over the FOCC. Cellular devices that travel from one paging area to another paging area must transmit an autonomous registration signal or the MDRD 29 will be lost to its home CMR system.

While a conventional CMR systems will trigger an autonomous registration signal from a conventional radiotelephone, an MDRD 29 may require other triggers to effectively register with its home CMR system (i.e., the data service provider 46). A CMR system must be compatible with the data message system in order for it to provide for data message communication between the MDRD 29 and the data service provider 46. Compatible CMR systems can be identified by their SIDs. At the data message gateway 46, a Master SID List may be maintained for identifying CMR systems that are compatible with the data message system. Thus, MDRDs 29 can generate registration signals when they enter a new paging area like any other cellular device. MDRDs 29 can also transmit registration signals in response to other trigger events that do not affect ordinary cellular devices. In order to differentiate these registration signals from the autonomous registration signal, they are referred to as maintenance messages. Maintenance messages serve the same purposes as the autonomous registration signal, except that they also serve to identify CMR systems that are compatible with the data message system. When compatible CMR systems are newly discovered, the SID corresponding to the new CMR system can be added to the Master SID List. The various means for triggering a maintenance message will now be described, followed by a description of the Master SID List and its use.

Maintenance Message Triggering Events

As discussed above in connection with FIG. 1, the MDRD 29 will generate a maintenance message to inform the data service provider 46 of the MDRD's 29 (FIG. 1) electronic location. Once the data service provider 46 receives the maintenance message, it can send control messages to the MDRD 29 in the specific paging area identified by the maintenance message.

The first event that will trigger a maintenance message, is a change in the SID that is transmitted over the FOCC that the MDRD 29 is monitoring. A typical CMR system will transmit a SID over the FOCC about once every second. By comparing a recently received SID to a previously received SID, an MDRD 29 can recognized a change in the CMR system's SID. Typically, this change in SID will indicate that the MDRD 29 has traveled from the paging area of one CMR system into a paging area of another CMR system. This situation is depicted in FIG. 2.

In FIG. 2, an MDRD 29 is aboard a long-haul truck that is traveling between a paging area of a first CMR system 100 and a paging area of a second CMR system 102. As the MDRD 29 passes between the paging areas, it will be handed-off to the paging area into which the MDRD 29 is entering. As with any cellular device, the MDRD 29 will continue monitoring the FOCC of the second CMR system 102, just as it monitored the FOCC of the first CMR system 100. Eventually a SID identifying the second CMR system will be transmitted over the FOCC. As discussed above, adjacent CMR systems typically have distinct SIDs. By comparing the newly received SID to the most recently received SID (that of the first CMR system 100), the MDRD 29 will detect that it has changed paging areas and will transmit a maintenance message to the MSC 24 via the RECC of the second CMR system 102.

The maintenance message will eventually be forwarded to the data message gateway and on to the service provider 49, thus apprising the data service provider 46 of the electronic location of the MDRD 29 (i.e., the CMR system's SID and the switch number corresponding to the particular paging area). Thereafter, the service provider can direct control messages to the MDRD 29 by sending a page only to the newly entered paging area of the second CMR system 102. This maintenance message triggering mechanism can be used every time the MDRD 29 travels between paging areas of different CMR systems.

In some CMR systems, however, the SID cannot be used to distinguish between adjacent paging areas and/or adjacent CMR systems. For example, in Canada, every CMR system uses the same SID. In such a case, monitoring the FOCC for a change in SID will be an ineffective means of keeping a service provider apprised of the electronic location of an MDRD 29. A second event that will trigger a maintenance message, is a drastic change in the REGID transmitted by the CMR system. As discussed in connection with FIG. 1, a conventional CMR system will transmit a REGID over the FOCC periodically. By using the NEXTREG and REGINCR values described above, the MDRD 29, like any cellular device, can identify a transition from a first

CMR system to a second CMR system when there is a drastic, unexpected change in the REGID value.

In the example of FIG. 2, the MDRD 29 will continually monitor the FOCC of the first CMR system 100 for its REGID. As the MDRD 29 enters the paging area of the second CMR system 102 and is handed-off to the second CMR system 102, the MDRD 29 will begin monitoring the FOCC of the second CMR system 102. If the SID of the second CMR system 102 is different than the SID of the first CMR system 100, then the MDRD 29 will generate a maintenance message as described above. However, if the SIDs of the two CMR systems are the same, then the REGIDs of the CMR systems can be compared. If the REGID of the second CMR system 102 is drastically different than that of the first CMR system 100, then the MDRD 29 will generate a maintenance message. Generally, a newly received REGID is drastically different from the previously received REGID when it is at least greater than the NEXTREG value or less than the previously received REGID value.

As mentioned above, any given paging area is generally serviced by two CMR systems (carriers). Conventional CMR systems are designed such that they communicate on one of two available channels. Specifically, a carrier is either a "System A" carrier or a "System B" carrier. This arrangement simply divides the available spectrum of cellular network frequencies in any given paging area into two sets and designates one set to the System A carrier and the other to the System B carrier. This arrangement was originally adopted to allow for two competitors to operate co-extensively in any given cellular market.

Some carriers do not support data message communications. For example, such carriers may not provide for the transmission of various data messages and/or control messages between the MDRD 29 and the data service provider 46. In the System A/B arrangement described above, it is common that only one of the carriers (either the "System A" carrier or the "System B" carrier) will support data message communications. It is also common that both or neither carrier supports data message communications. In such cases, the MDRD 29 must test both channels to determine which to monitor for a triggering event.

Referring still to FIG. 2, as the MDRD 29 travels from the first CMR system 100 to the second CMR system 102, the data message communications supportive channel changes from the System A carrier in the first CMR system 100 to the System B carrier in the second CMR system 102. The MDRD 29 will recognize that it must generate a maintenance message, in one of the ways described above. However, it must determine which of the two channels to utilize to transmit the maintenance message. Assuming that only

one of the two carriers in the second CMR system 102 supports data message communications, the MDRD 29 will react in one of two ways. If the MDRD 29 is monitoring the data message communication supportive channel, then the MDRD 29 can simply generate the maintenance message using the carrier that operates that channel. On the other hand, if the MDRD 29 is monitoring the non-supportive channel, then it must switch to the other channel and then generate the maintenance message. The MDRD 29 must, therefore, make a determination as to which channel is the supportive channel. This is done by means of a SID list.

The SID List

The SID list includes a SID for each carrier that provides data message communications support. Each MDRD 29 can be pre-programmed with a SID list. When the MDRD 29 recognizes entry into a new paging area and prepares to generate a maintenance message, the MDRD 29 first monitors the FOCC of the newly entered paging area to determine the SID of the corresponding carrier. Once the SID has been determined, the SID is compared to the MDRD's 29 SID list for a match. If a match is found , then the MDRD 29 generates a maintenance message and continues normal operation. If no match is found, then the MDRD 29 switches channels in order to monitor the FOCC of the other carrier and attempts to match that carriers SID to the MDRD's 29 SID list.

The SID list can also contain a trigger flag corresponding to each SID in the SID list. Each CMR system represented by a SID in the SID list has a preferred method of triggering a maintenance message. Some CMR systems are configured to trigger the maintenance message by the REGID method described above, while others are configured to use the SID change method. In either case, the MDRD 29 can conform its method of generating a maintenance message based on the trigger flag in the SID list.

Referring now to FIG. 3, an exemplary paging area 300 is depicted having two carriers, Carrier A 302 and Carrier B 304. The FOCCs 306, 308 of each carrier contain the SIDs 310, 312 identifying each carrier. The MDRD 29 has a SID list 314 containing SIDs 316 known to support data message communications. The MDRD 29 can compare Carrier A's SID 310 to its SID list to determine whether Carrier A supports data message communications. Because the Carrier A SID 310 does not match any SID in the SID list 314, the MDRD 29 will switch channels to monitor the FOCC of Carrier B 304. The MDRD 29 compares the Carrier B SID 312 to the SID list 314 and determines

that there is a match with SID 316. Once the match is made, the MDRD 29 will generate a maintenance message via the RECC 318 of Carrier B.

A third event will trigger a maintenance message in the situation in which neither Carrier is transmitting a SID that matches a SID on the MDRD's 29 SID list. In this case, the MDRD 29 will monitor the FOCCs of each carrier to look for data message communication traffic. The data packets that make up control messages directed to MDRDs 29 typically contain an identifying characteristic that indicate that the data packets are data message system control messages. For example, in an exemplary data message system, the high order of the MIN, the MIN2 (corresponding to the area code in a called telephone number), will contain the digits "007". This identifying characteristic allows CMR systems and other cellular devices to process the control messages more efficiently, because the "007" MIN2 is typically reserved for use as a data message identifier. That is, other data packets that are travelling on the FOCC do not contain this particular MIN2. Cellular devices that are not associated with any data message system will simply ignore data packets containing the "007" MIN2. Those skilled in the art will appreciate that any information transmitted over the FOCC or the RECC can be used to identify the existence of data message communication traffic.

If the identifying characteristic of data message communication traffic is recognized by the MDRD 29, then the MDRD 29 can generate a maintenance message and the service provider will be apprised of the MDRD's 29 electronic location. If, however, the identifying characteristic is not detected by the MDRD 29, then it will simply generate a system verification registration. The system verification registration is simply a request that the service provider send a system verification page to the MDRD 29 in the last known paging area. If a system verification page is received by the MDRD 29, then it knows that the carrier with which it is communicating supports data message communication, because only carriers that support data message communication will forward a system verification registration to a service provider.

If a system verification page is not received within a predetermined period, then the MDRD 29 will switch channels to the other carrier in the paging area and send another system verification registration. If a system verification page is again not received within the predetermined period, then the MDRD 29 will simply default to one of the two carriers and continue monitoring the FOCC for data message communication traffic. Notably, when the MDRD 29 enters another paging area, the MDRD 29 will again attempt to apprise the service provider of the electronic location of the MDRD 29.

In the case in which neither carrier is recognizable to the MDRD 29 as being supportive of data message communication, the service provider will not be apprised of the MDRD's 29 electronic location. However, the service provider may attempt to determine the electronic location of the MDRD 29 through other means. One such means is to flood page all paging areas adjacent to the paging area encompassing the last-known electronic location of the MDRD 29. Another means is to use algorithms tailored to the specific service provider's operation. For example, if the long-haul trucking service provider is aware that the last-known electronic location corresponds to a particular physical location, the new physical location might be predictable and might be convertible to an electronic location. If, for example, the last known physical location of a long-haul truck was southbound on Interstate 45 between Dallas and Houston, a page may be sent to one or more paging areas corresponding to progressively southern physical locations along Interstate 45. Those skilled in the art will appreciate that any number of algorithms may be utilized to identify the physical location of an MDRD 29.

An Exemplary Method for Registering the Electronic Location of a Mobile Data Reporting Device

Turning now to FIG. 4a, an exemplary method for registering the electronic location of an MDRD is depicted. The method begins at step 400, in which the MDRD is operating normally. That is, the MDRD is either communicating as designed with the service provider, or the MDRD is lost to the service provider and data message communications have been suspended. In either case, the method proceeds to decision block 402 wherein a determination is made as to whether the current trigger flag is set to generate a maintenance message in response to a SID change. If the trigger flag is set to SID change, then the method proceeds to decision block 404, wherein a determination is made as to whether a SID change has been detected. If a SID change has not been detected, then the method branches back to decision block 402. On the other hand, if a SID change has been detected at decision block 404, then the method branches to step 408.

Returning now to decision block 402, a determination that the trigger flag is not set to SID change necessarily means that the trigger flag is set to REGID change and the method branches to decision block 406. At decision block 406, a determination is made as to whether a drastic change in the REGID has been detected. If such a change has not been detected, then the method branches back to decision block 402. On the other hand, if a drastic REGID change has been detected, then the method branches to step 408.

Turning now to FIG. 4b, at step 408, the MDRD switches to its default channel. Typically cellular devices are pre-programmed to default to one of the two channels corresponding to the carriers within any given paging area. The method then proceeds to step 410 wherein the MDRD monitors the FOCC of the default carrier for a SID. The method then proceeds to step 412 where the MDRD compares a received SID to the MDRD's SID list. The method proceeds to decision block 414 where a determination is made as to whether a match is found between the received SID and a SID in the SID list. If a match is found, then the method branches to step 416 and the MDRD generates a maintenance message. The method then proceeds to step 418 and the MDRD's trigger flag is set to the trigger flag corresponding to the matched SID in the SID list. Once the trigger flag has been set, the method simply returns to normal operation at step 400.

Returning to decision block 414, when no match is found, the method branches to step 420 and the MDRD switches to the other carrier. The method then proceeds to step 422 and the MDRD monitors the FOCC of the non-default carrier for a SID. The method then proceeds to step 424 where a received SID is compared to the SID list. The method proceeds to decision block 426 where a determination is made as to whether a match is found between the received SID and a SID in the SID list. If a match is found, then the method branches to step 428 and the MDRD generates a maintenance message. The method then proceeds to step 430 and the MDRD's trigger flag is set to the trigger flag corresponding to the matched SID in the SID list. Once the trigger flag has been set, the method simply returns to normal operation at step 400. If no match is found at decision block 426, or no SID is detected on either carrier's FOCC, then the method branches to step 432 and the MDRD switches into data message traffic monitoring mode as is discussed in more detail below in connection with FIG. 5.

Turning now to FIG. 5, an exemplary method for triggering a maintenance message is depicted for CMR systems having a SID not matching any on the SID list. The method starts at step 500 where the MDRD switches to monitor the channel corresponding to its default carrier. The method proceeds to step 502, wherein the MDRD monitors the FOCC for control messages containing a predetermined characteristic identifying data message communication. The method proceeds to decision block 504 where a determination is made as to whether the predetermined characteristic has been detected within a predetermined period. If the predetermined characteristic is detected, then the method branches to step 506 and a maintenance message is generated. The detection of the predetermined characteristic indicates that the

CMR system with which the MDRD is communicating supports data message communication. Accordingly, the method then branches to step 508 and adds the SID of the CMR system to the MDRD's SID list. At this step, the method also sets the trigger flag corresponding to the added SID to REGID change, which is the default trigger mechanism for CMR systems. Once the SID has been added to the SID list, the method simply returns to normal operation at step 400 (FIG. 4a).

Returning now to decision block 504, where a control message containing a predetermined characteristic is not detected, the method branches to step 510. At step 510, the MDRD switches to the non-default channel corresponding to the other carrier, because it is assumed that the default carrier does not support data message communications. The method proceeds to step 514 and the MDRD monitors the FOCC for a control message containing the predetermined characteristic. The method proceeds to decision block 516 and a determination is made as to whether the predetermined characteristic has been detected within a predetermined period. If the predetermined characteristic is detected, then the method branches to step 506 and the maintenance message is generated as described above.

If, on the other hand, the predetermined characteristic is not detected, then the method branches to step 518 and a system verification registration is generated. The method proceeds to step 50 and a determination is made as to whether a system verification page is received within a predetermined period. If the system verification page is received, then the method branches to step 506 and the maintenance message is generated as described above. If the system verification page is not received within a predetermined period, then the method branches to step 522 and the MDRD switches to the other carrier. The method proceeds to step 524 and the MDRD generates a system verification registration via the new carrier. The method proceeds to decision block 526 and a determination is made as to whether a system verification page is received within a predetermined period. If a system verification page is received, then the method branches to step 506 and the maintenance message is generated as described above.

If a system verification page is not received at decision block 526, then the method branches to step 528 where the MDRD alternates between the two carriers, simply monitoring both carriers for the predetermined characteristic indicating that the carrier supports data message communication. The method proceeds to decision block 530. If, while monitoring both carriers, the MDRD detects a new SID or a drastic change in REGID (depending on the trigger flag), then the method branches back to step 408 and the method proceeds as described

above. If no SID change or drastic REGID change is detected, then the method keeps monitoring the carriers for the predetermined characteristic by continually branching back to step 528.

Updating the SID List

In order to maintain a SID list that contains all CMR systems that support data message communications, the Master SID List and the SID list in each MDRD 29 must be updated regularly. The Master SID List is maintained at a central site, such as the data message gateway. The Master SID List can be updated when arrangements are made with carriers to support data message communications. Alternatively, when an MDRD determines that a carrier supports data message communications despite not being on the MDRD's SID list, then the carrier's SID can be added to the Master SID List. Of course carriers can be removed from the Master SID List as well.

The MDRD SID lists can be updated by flood paging over all carriers that support data message communications. A series of update control messages can be sent to the MDRDs at regular intervals. For example, update control messages can be transmitted on the first and middle of each month, containing information on which carriers' SIDs have been added and deleted from the Master SID List.

The update control messages can be serialized in order to maintain a proper sequence. A particular sequence may be necessary where a large number of SIDs must be added and/or deleted from the Master SID List. Similarly, a single control message may be incapable of containing an entire SID. In either case, a serializer digit can be used within the update control message to indicate the sequence of a set of update control messages. For example, the serializer digit may indicate that a particular update control message is the fifth out of a series of ten update control messages. If a MDRD receives an update control message that is out of order, then it can piece together the SID list changes and/or ignore the out-of-order information. Those skilled in the art will appreciate that there are various well known means of ordering a stream of data.

The above description is directed toward the exemplary embodiment of the present invention in which a maintenance message is generated to identify the electronic location of a mobile data reporting device within the context of a data message system. However, those skilled in the art will appreciate the invention can be utilized within the context of other cellular network applications, such as radiotelephone communications and paging

systems. The above description is not intended to limit the application of the invention to data message systems.

CLAIMS

We claim:

1. In or for a cellular mobile radiotelephone (CMR) system having a first system identification number (SID) that identifies the CMR system, a data message system comprising:

a plurality of mobile data reporting devices (MDRDs) for monitoring a plurality of data sources and transmitting selected data in a data message to a mobile switching center (MSC) via a reverse control channel (RECC) and for receiving control messages from the MSC via a forward control channel (FOCC);

a data message gateway connected to the MSC via a first communications link and operative to receive the selected data from the MSC and to transmit the control messages to the MSC for delivery to at least one of the MDRDs;

wherein each MDRD comprises a SID list that contains a plurality of SIDs, each SID in the SID list identifying a CMR system that is capable of supporting data message communications; and

wherein each MDRD is further operative to transmit a maintenance message via the RECC, the maintenance message identifying an electronic location of the MDRD to the data message gateway.

2. The data message system of Claim 1, wherein the maintenance message comprises a SID and a switch number operative to identify the electronic location of the MDRD.

3. The data message system of Claim 1, wherein the MDRD generates the maintenance message in response to a triggering event.

4. The data message system of Claim 3, wherein the triggering event comprises a determination by the MDRD that it has received a SID that is different than a previously received SID.

5. The data message system of Claim 4, wherein the MDRD is further operative to compare the received SID to a SID list, and wherein the MDRD will generate the maintenance message in response to matching the received SID to a SID in the SID list.

6. The data message system of Claim 5, further comprising a Master SID List, wherein the SID list is updated in response to a change to the Master SID List.

7. The data message system of Claim 6, wherein the SID list is updated by at least one update control message received by the MDRD.

8. The data message system of Claim 6, wherein the SID list is updated by a group of update control messages that are serialized to maintain a predefined sequence.

9. The data message system of Claim 3, wherein the triggering event comprises a determination by the MDRD that it has received a Registration Identifier (REGID) value that is substantially different than a previously received REGID value.

10. The data message system of Claim 3, wherein the triggering event comprises a determination by the MDRD that it has received a Registration Identifier (REGID) value that is substantially different than a Next Registration (NEXTREG) value.

11. The data message system of Claim 1, wherein the MDRD is further operative to determine that the CMR system supports data message communications by monitoring data communication traffic on a control channel of the CMR system.

12. The data message system of Claim 11, wherein the MDRD generates the maintenance message in response to a determination that the data communication traffic comprises a predetermined characteristic of a data message communication.

13. The data message system of Claim 12, wherein the predetermined characteristic comprises a data message having a predetermined MIN value.

14. In or for a first cellular mobile radiotelephone (CMR) system having a first system identification number (SID), the CMR system operative to communicate with cellular devices within at least one paging area, a method for determining an electronic location of at least one mobile data reporting device (MDRD) operating within the paging area, the method comprising the steps of:

monitoring a forward control channel (FOCC) of the first CMR system for a control message containing the first SID;

comparing the first SID to a SID list containing a plurality of SIDs, in response to a first MDRD receiving the first SID; and

transmitting a maintenance message, the maintenance message operative to identify an electronic location of the first MDRD, in response to a match between the first SID and at least one of the SIDs in the SID list.

15. The method of Claim 14, wherein the maintenance message comprises the first SID and a switch number.

16. The method of Claim 14, further comprising the step of generating the maintenance message, in response to a triggering event.

17. The method of Claim 16, wherein the triggering event is a passage of the first MDRD from a paging area of the first CMR system to a paging area of the second CMR system.

18. The method of Claim 17, further comprising the steps of:

monitoring the FOCC of the first CMR system for a first register identifier (REGID) value and for a register increment (REGINCR) value;

setting a next register (NEXTREG) value equal to the REGID value added to the REGINCR value;

monitoring the FOCC of the second CMR system for a second REGID value and comparing the NEXTREG value to the second REGID value; and

generating the maintenance message, in response to the NEXTREG value being substantially different than the second REGID value.

19. The method of Claim 17, further comprising the steps of:

monitoring the FOCC of the first CMR system for the first SID;

monitoring the FOCC of the second CMR system for a second SID; and

generating the maintenance message, in response to the first SID being different than the second SID.

20. The method of Claim 14, further comprising the steps of:

updating a Master SID List to add or delete SIDs; and

updating the SID list to conform the SID list to the Master SID List, in response to an update to the Master SID List.

21. The method of Claim 20, further comprising the step of transmitting at least one update control message containing at least a portion of the Master SID List.

22. The method of Claim 21, further comprising the step of transmitting a group of update control messages, each update control message serialized to maintain a predefined sequence.

23. The method of Claim 14, further comprising the step of making a determination as to whether the first CMR system supports data message communications.

24. The method of Claim 23, further comprising the step of monitoring data communication traffic on a control channel of the first CMR system.

25. The method of Claim 24, further comprising the step of generating the maintenance message in response to a determination that the data communication traffic comprises a predetermined characteristic of a data message communication.

26. The method of Claim 25, wherein the predetermined characteristic comprises a data message having a predetermined MIN value.

27. In or for a cellular mobile radiotelephone (CMR) system for communicating with cellular devices within at least one paging area, an electronic location registration system for identifying the electronic location of a mobile data reporting device (MDRD) operating within the at least one paging area, the electronic location registration system comprising:

a plurality of mobile data reporting devices (MDRDs) for monitoring a plurality of data sources and transmitting selected data in a data message to a mobile switching center (MSC) via a reverse control channel (RECC) and for receiving control messages from the MSC via a forward control channel (FOCC);

each MDRD comprising a system identification number (SID) list, the SID list containing a plurality of SIDs, each SID identifying a particular CMR system that is capable of supporting data communication by the MDRDs;

each MDRD further operative to generate a maintenance message identifying the CMR system and MSC with which the MDRD is communicating, in response to a trigger event; and

a data message gateway connected to the MSC via a first communications link and operative to receive the selected data from the MSC and to transmit the control messages to the MSC for delivery to at least one of the MDRDs.

28. The electronic location registration system of Claim 27, wherein the maintenance message comprises a SID and a switch number operative to identify the electronic location of the MDRD.

29. The electronic location registration system of Claim 27, wherein the triggering event comprises a determination by the MDRD that it has received a SID that is different than a previously received SID.

30. The electronic location registration system of Claim 27, wherein the triggering event comprises a determination by the MDRD that it has received a Registration Identifier (REGID) value that is substantially different than a previously received REGID value.

31. The electronic location registration system of Claim 27, further comprising a Master SID List, wherein the SID list is updated in response to a change to the Master SID List.

32. The electronic location registration system of Claim 31, wherein the SID list is updated by at least one update control message received by the MDRD.

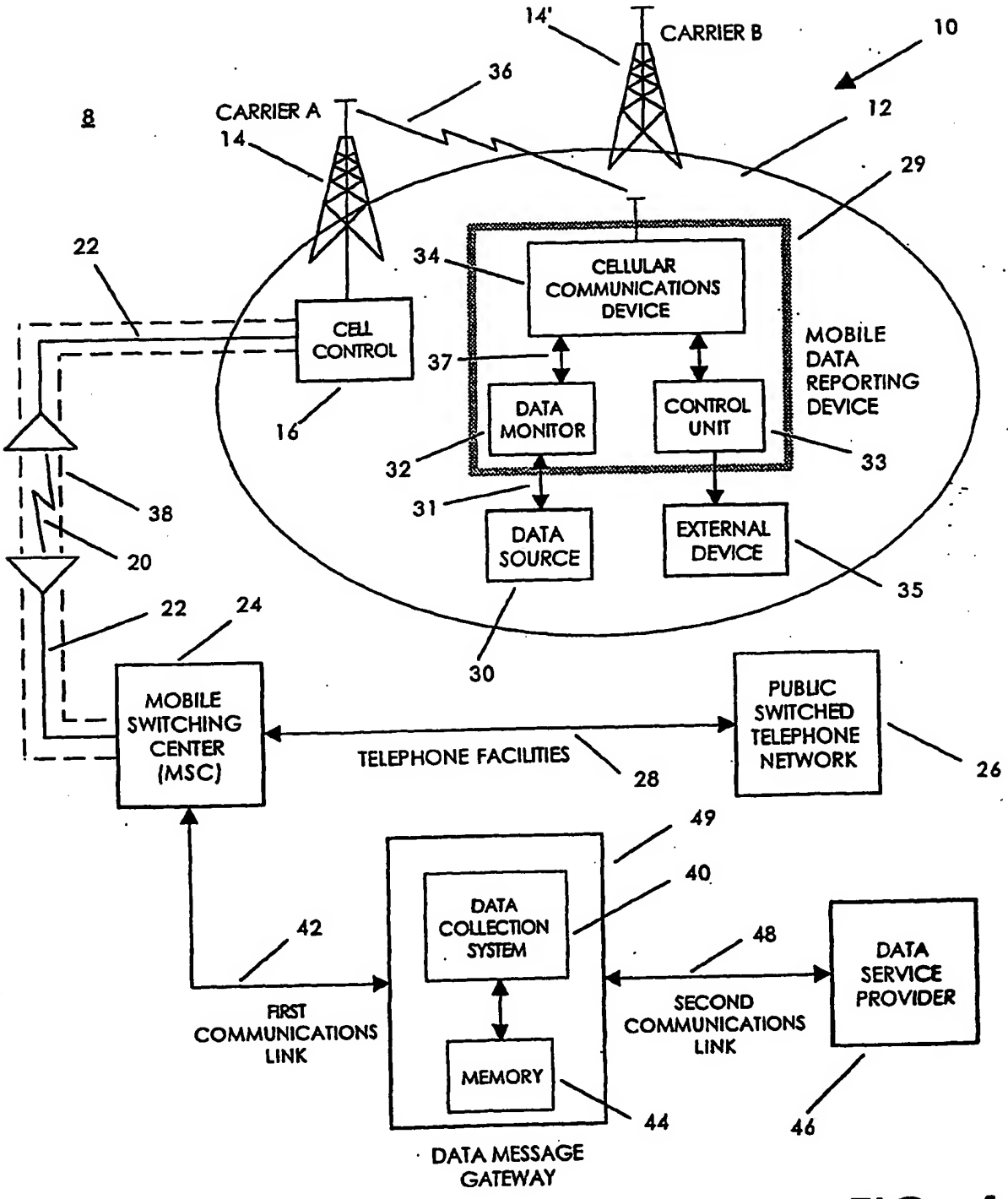

14'
CARRIER B
10
36
8
CARRIER A
14
12
29
22
34
CELLULAR COMMUNICATIONS DEVICE
CELL CONTROL
37
MOBILE DATA REPORTING DEVICE
DATA MONITOR
CONTROL UNIT
16
32
33
38
31
20
DATA SOURCE
EXTERNAL DEVICE
35
22
24
30
MOBILE SWITCHING CENTER (MSC)
PUBLIC SWITCHED TELEPHONE NETWORK
TELEPHONE FACILITIES
28
26
49
40
DATA COLLECTION SYSTEM
42
48
DATA SERVICE PROVIDER
FIRST COMMUNICATIONS LINK
SECOND COMMUNICATIONS LINK
MEMORY
44
46
DATA MESSAGE GATEWAY

FIG. 1

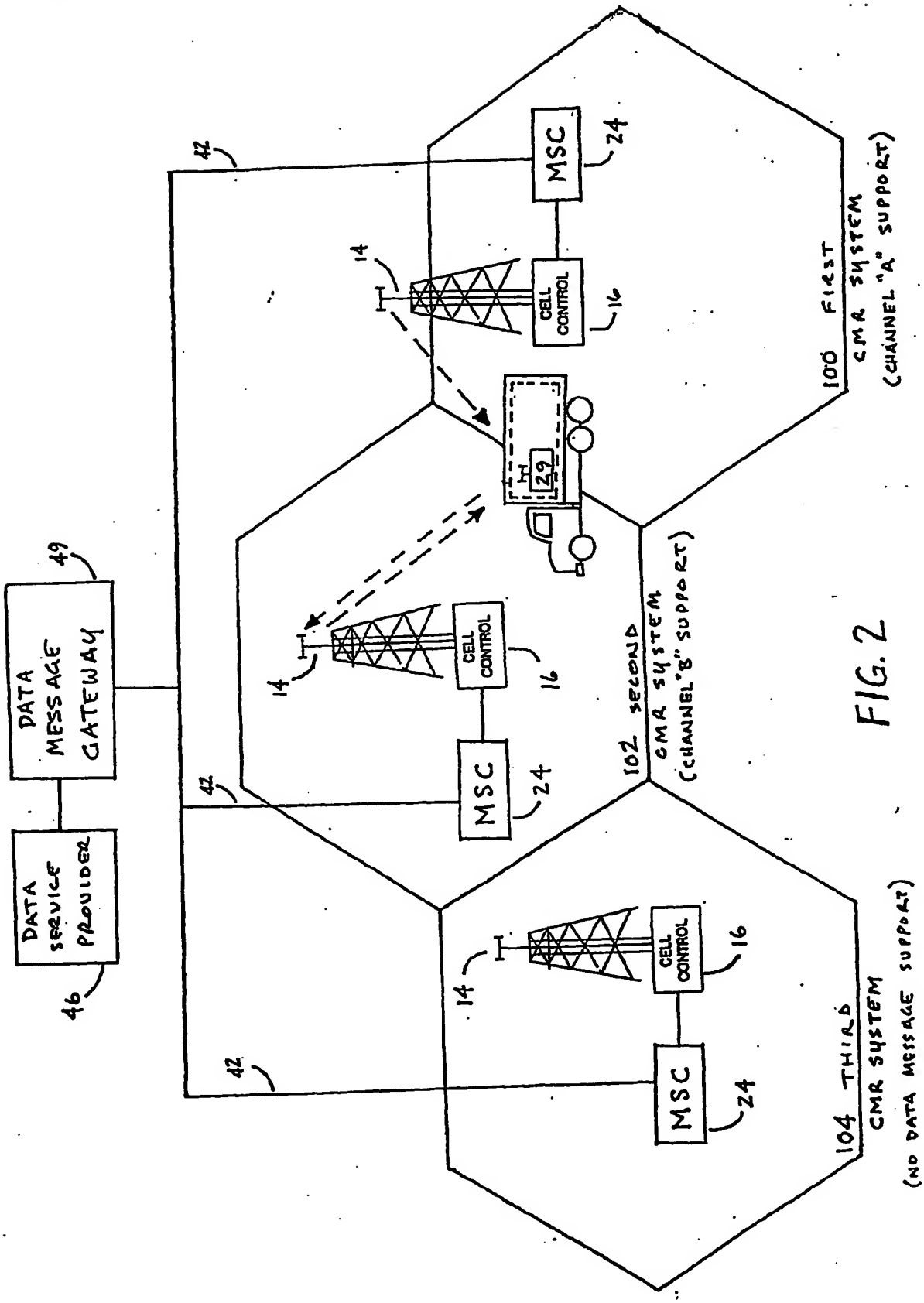

DATA MESSAGE GATEWAY
49
DATA SERVICE PROVIDER
46
42
MSC
24
CELL CONTROL
16
14
29
100 FIRST CMR SYSTEM (CHANNEL "A" SUPPORT)
102 SECOND CMR SYSTEM (CHANNEL "B" SUPPORT)
104 THIRD CMR SYSTEM (NO DATA MESSAGE SUPPORT)

FIG. 2

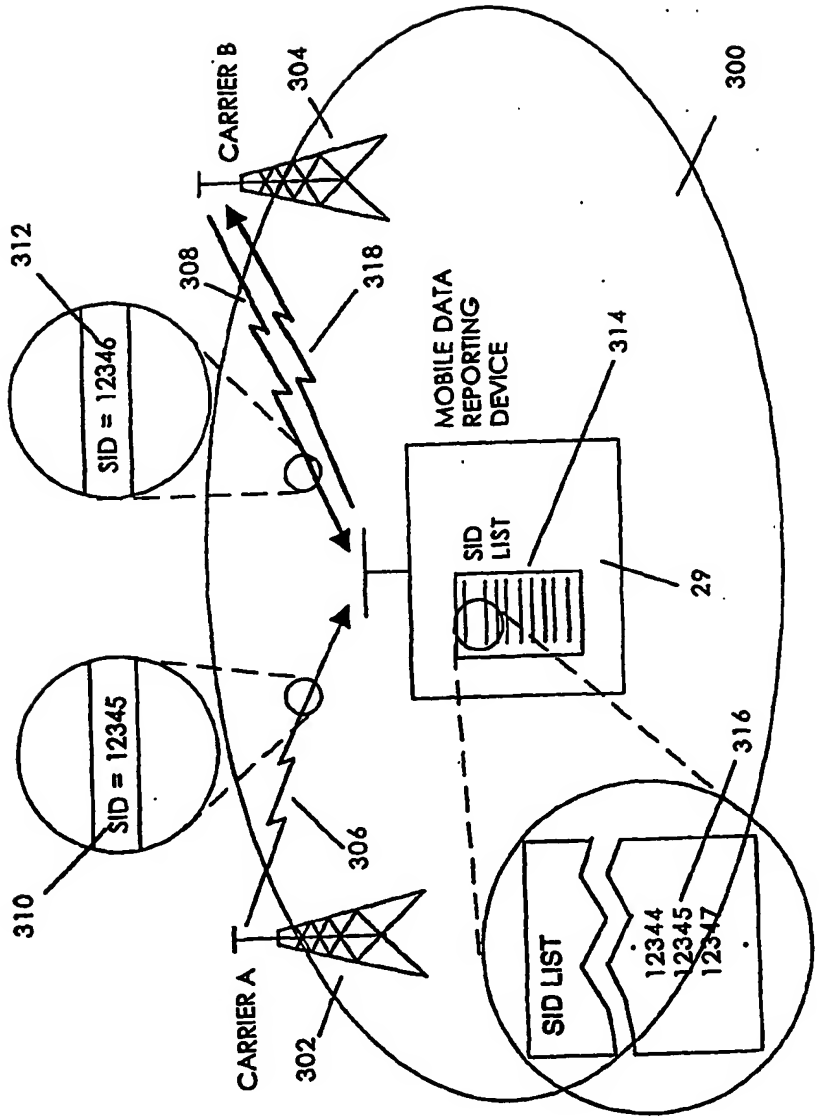

CARRIER B
304
300
312
308
318
SID = 12346
MOBILE DATA REPORTING DEVICE
314
SID LIST
29
SID = 12345
316
306
310
SID LIST
12344
12345
12347
CARRIER A
302

FIG. 3

FIG. 4a

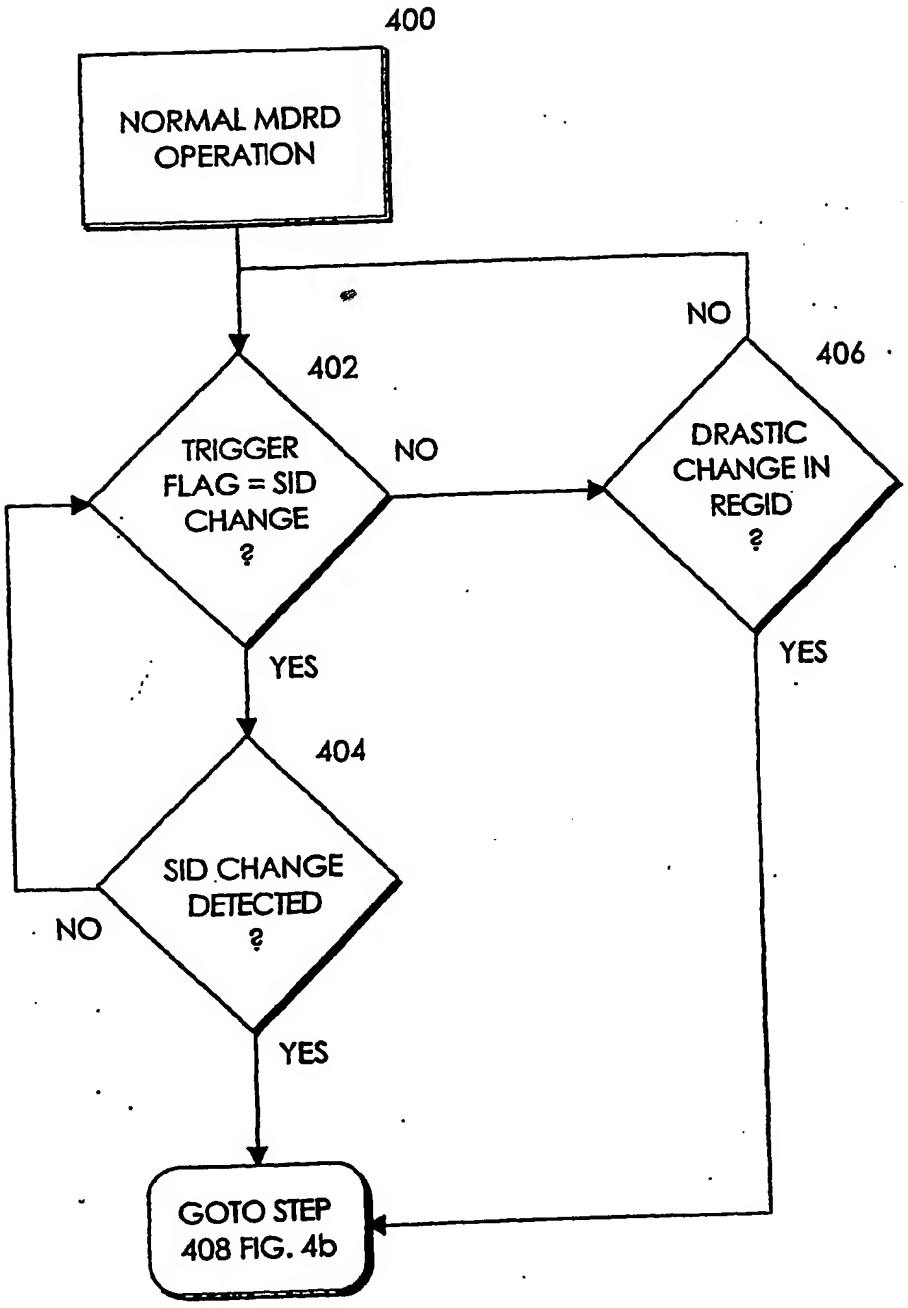

400
NORMAL MDRD OPERATION
402
TRIGGER FLAG = SID CHANGE ?
NO
406
DRASTIC CHANGE IN REGID ?
NO
YES
YES
404
SID CHANGE DETECTED ?
NO
YES
GOTO STEP 408 FIG. 4b

FIG. 4b

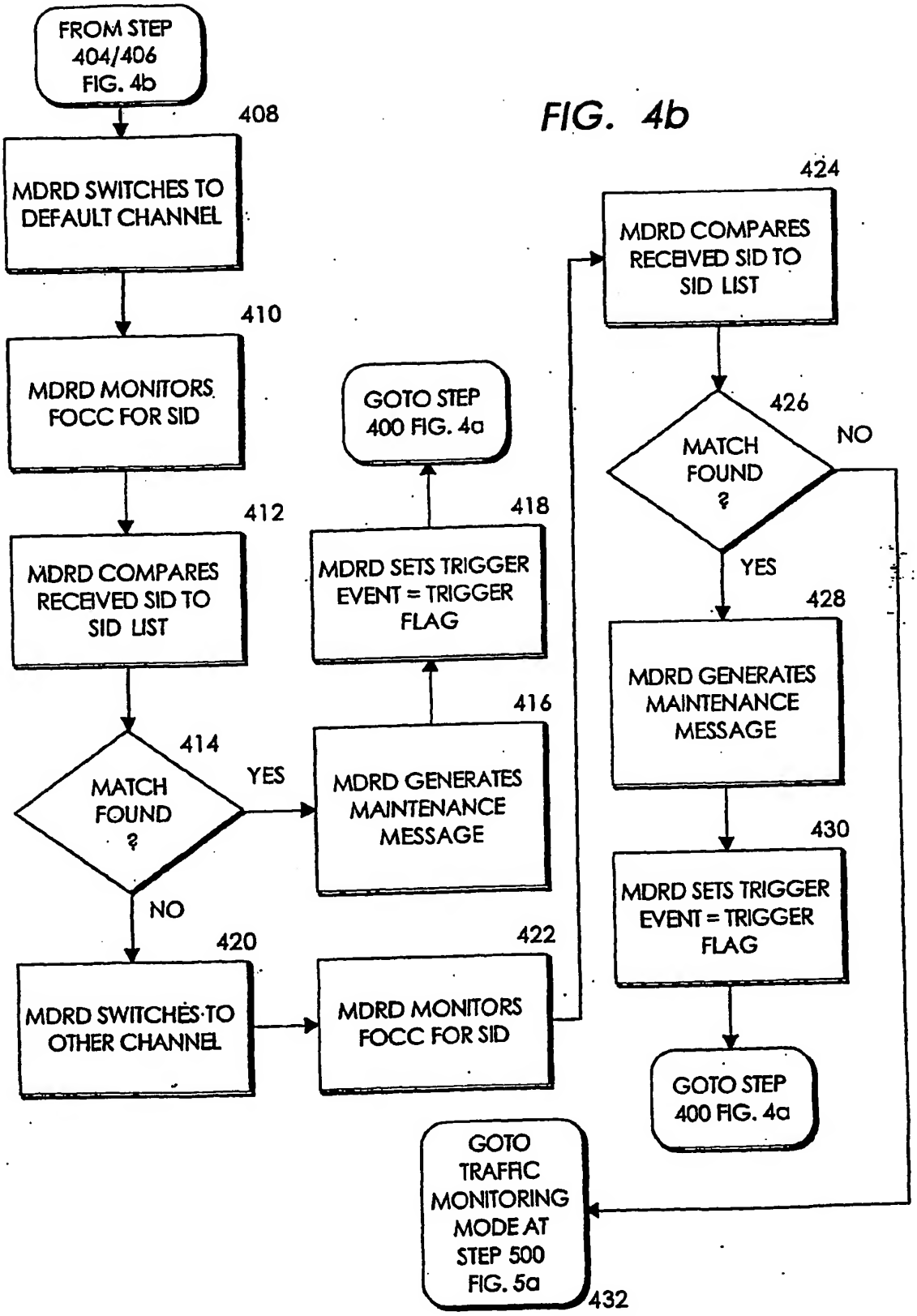

FROM STEP 404/406 FIG. 4b
408
MDRD SWITCHES TO DEFAULT CHANNEL
410
MDRD MONITORS FOCC FOR SID
412
MDRD COMPARES RECEIVED SID TO SID LIST
414
MATCH FOUND ?
YES
NO
416
MDRD GENERATES MAINTENANCE MESSAGE
418
MDRD SETS TRIGGER EVENT = TRIGGER FLAG
GOTO STEP 400 FIG. 4a
420
MDRD SWITCHES TO OTHER CHANNEL
422
MDRD MONITORS FOCC FOR SID
424
MDRD COMPARES RECEIVED SID TO SID LIST
426
MATCH FOUND ?
NO
YES
428
MDRD GENERATES MAINTENANCE MESSAGE
430
MDRD SETS TRIGGER EVENT = TRIGGER FLAG
GOTO STEP 400 FIG. 4a
GOTO TRAFFIC MONITORING MODE AT STEP 500 FIG. 5a
432

FIG. 5a

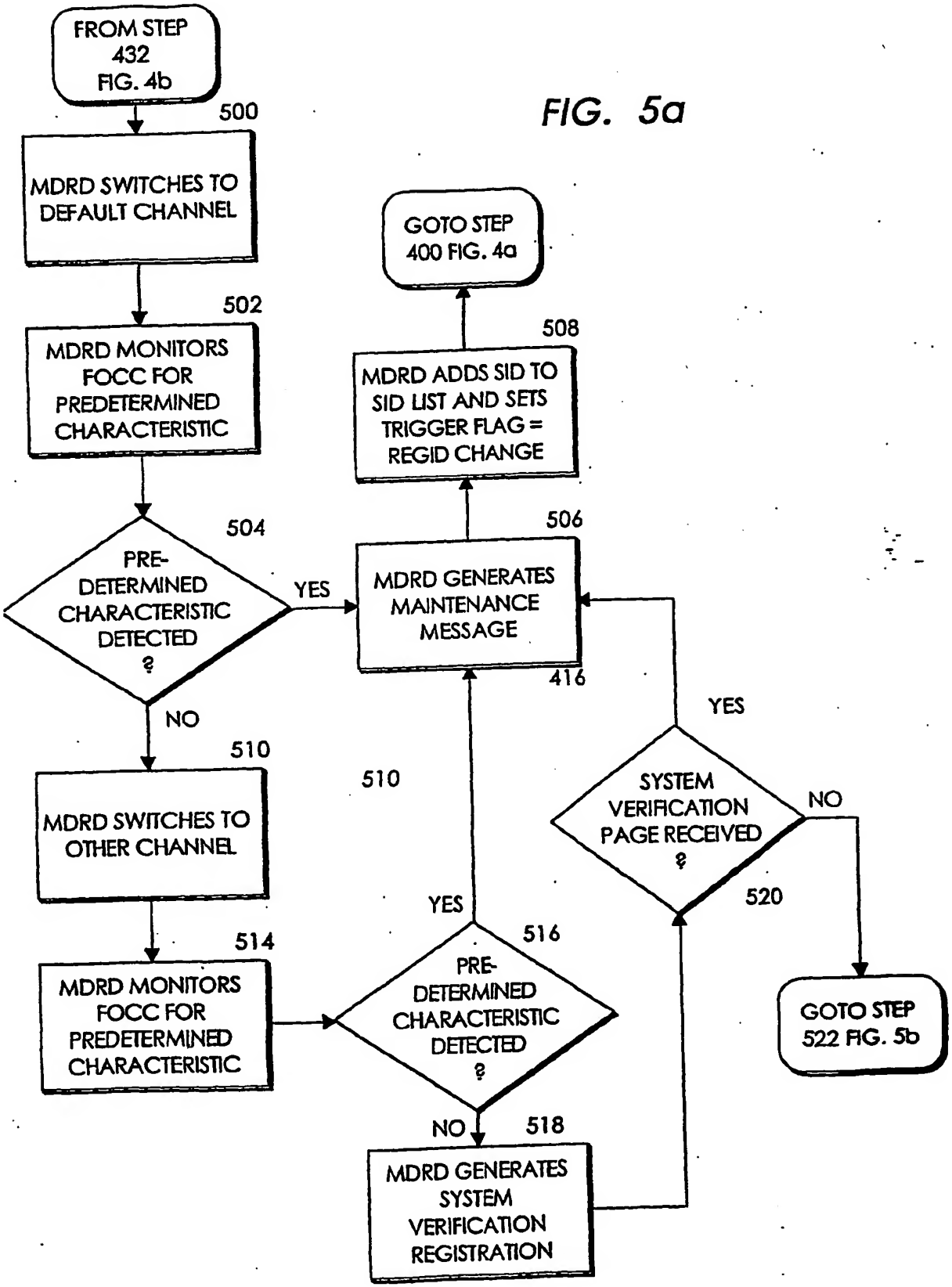
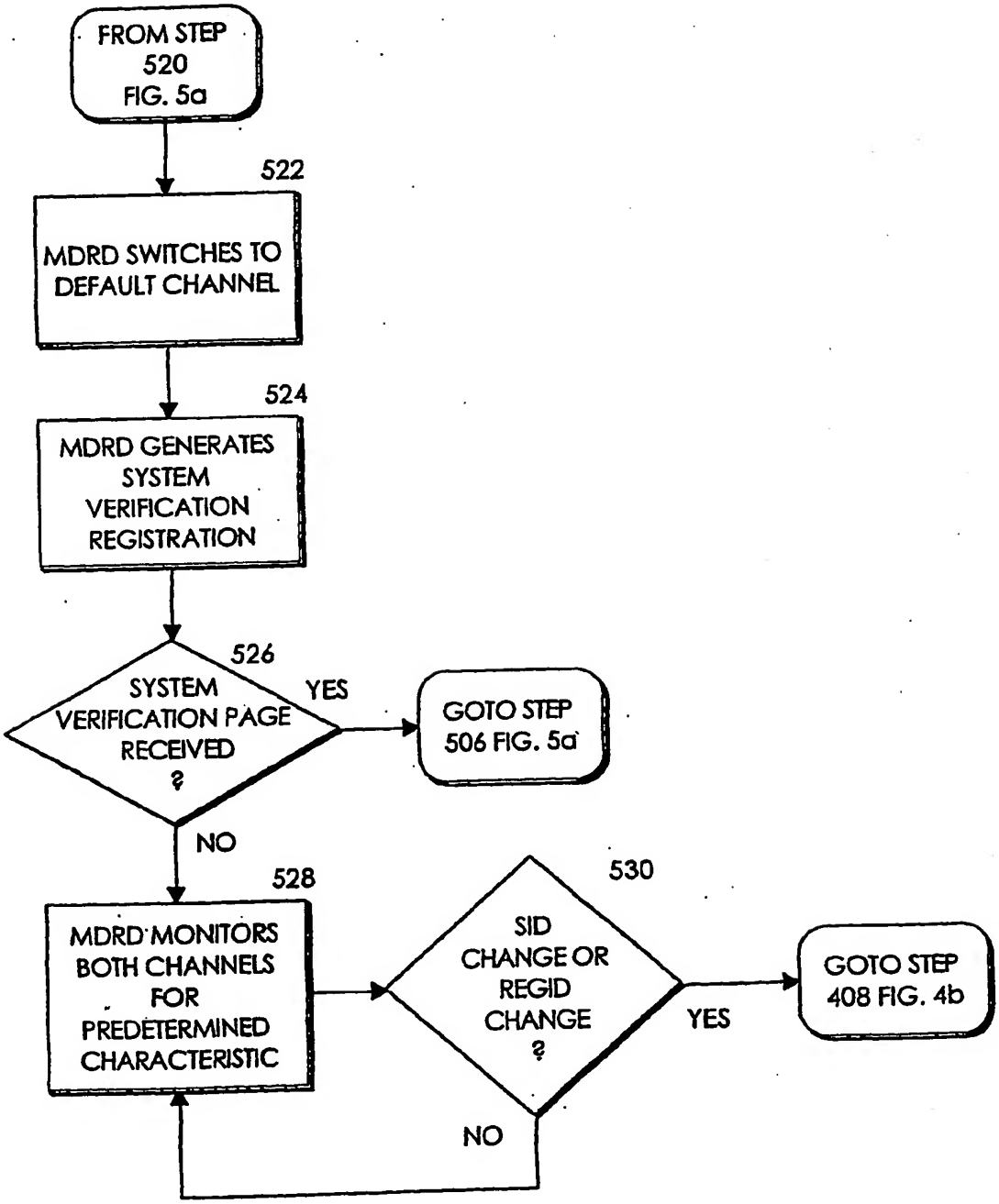

FROM STEP 432 FIG. 4b
500
MDRD SWITCHES TO DEFAULT CHANNEL
502
MDRD MONITORS FOCC FOR PREDETERMINED CHARACTERISTIC
504
PRE-DETERMINED CHARACTERISTIC DETECTED ?
YES
NO
510
MDRD SWITCHES TO OTHER CHANNEL
514
MDRD MONITORS FOCC FOR PREDETERMINED CHARACTERISTIC
516
PRE-DETERMINED CHARACTERISTIC DETECTED ?
YES
NO
518
MDRD GENERATES SYSTEM VERIFICATION REGISTRATION
510
506
MDRD GENERATES MAINTENANCE MESSAGE
416
508
MDRD ADDS SID TO SID LIST AND SETS TRIGGER FLAG = REGID CHANGE
GOTO STEP 400 FIG. 4a
YES
SYSTEM VERIFICATION PAGE RECEIVED ?
NO
520
GOTO STEP 522 FIG. 5b

FIG. 5b


FROM STEP 520 FIG. 5a
522
MDRD SWITCHES TO DEFAULT CHANNEL
524
MDRD GENERATES SYSTEM VERIFICATION REGISTRATION
526
SYSTEM VERIFICATION PAGE RECEIVED ?
YES
GOTO STEP 506 FIG. 5a
NO
528
MDRD MONITORS BOTH CHANNELS FOR PREDETERMINED CHARACTERISTIC
530
SID CHANGE OR REGID CHANGE ?
YES
GOTO STEP 408 FIG. 4b
NO

INTERNATIONAL SEARCH REPORT

Inter plication No
PCT/US 01/08977

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 5 862 480 A (WILD ET AL.) 19 January 1999 (1999-01-19) column 4, line 46 -column 17, line 26; figures	1,14 2,11-13, 15, 20-24, 27,28, 31,32
Y A	WO 96 38989 A (ERICSSON) 5 December 1996 (1996-12-05) page 10, line 27 -page 34, line 37; figures	1,14 2,11-13, 15, 20-24, 27,28, 31,32

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2001	20/08/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Geoghegan, C

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INTERNATIONAL SEARCH REPORT

Inter application No
PCT/US 01/08977

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99 26428 A (ERICSSON) 27 May 1999 (1999-05-27) page 7, line 19 -page 15, line 10; figures	1-32
A	US 5 748 104 A (ARGYROUDIS ET AL.) 5 May 1998 (1998-05-05) column 3, line 66 -column 15, line 45; figures	1,14,27
A	US 5 159 625 A (ZICKER) 27 October 1992 (1992-10-27) column 4, line 38 -column 20, line 25; figures	1,14,27

INTERNATIONAL SEARCH REPORT

information on patent family members

Inter Application No
PCT/US 01/08977

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			US	5884172 A	16-03-1999
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			AU	1058499 A	07-06-1999
			CN	1286876 T	07-03-2001
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